

AGRICULTURAL ENGINEERING

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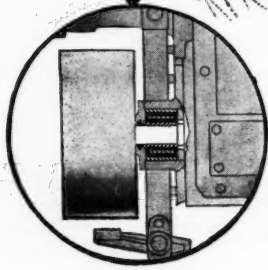
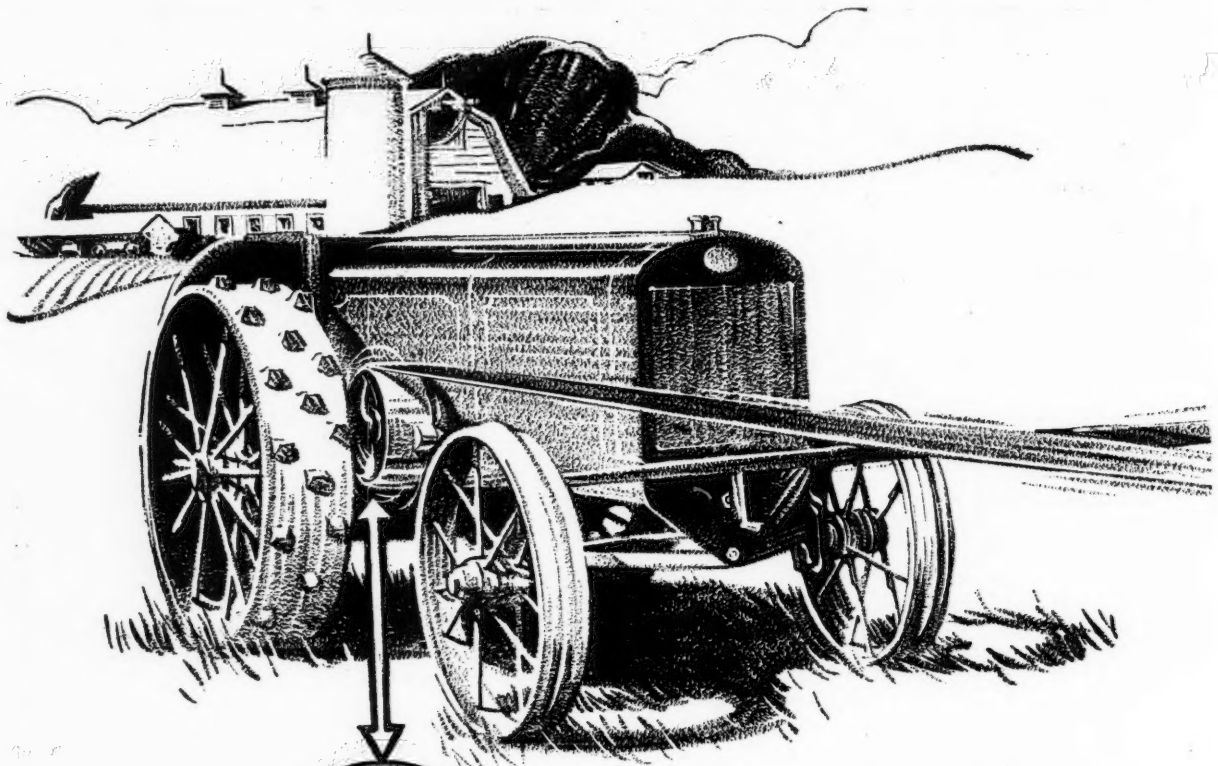
The Object and Scope of A. S. A. E. Activities

THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

- (a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.
- (b) Farm Structures—buildings and other structures and related equipment.
- (c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.
- (d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.
- (e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.



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Tests of Self-Supporting Barn Roofs

By A. W. Clyde

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Iowa State College

IF WE look at the facts squarely we must admit that little real engineering knowledge has ever been used in barn roof design. The common styles of self-supporting roofs were developed by so-called practical builders rather than by engineers. Generally speaking, we have followed their plans with little knowledge of what we were advocating. In the case of the wing-joint or braced rafter framing, we have even recommended changes which have weakened the original plan. When questioned about the strength of our designs, we have had to take refuge in the statement that most of the roofs were still standing. At best this a haphazard method of checking the strength of a building because it may be ten years or more before the structure is loaded severely. There is enough evidence of weakness in some of the modern light frame barns to show that cut-and-try methods do not produce satisfactory results.

One of the first things to do in planning a roof is to decide upon the loading we want it to carry and what factor of safety to provide. The wind load needs the most consideration in barn roofs. If it is cared for properly it is likely that the roof will meet other requirements. Shall we build for a wind of 50 miles per hour, or shall some other figure be chosen? The economic aspects must be considered. Perhaps it will be cheapest in the long run to build for a light wind load, carry insurance, and rebuild if an unusual storm occurs. The strength of the barn frame below the roof may be a limiting factor. The agricultural engineering department, Iowa State College, after considering these factors, has decided to make its plans insofar as practicable for a wind

*1922 report of the Committee on Farm Building Design.

of 60 miles per hour with a factor of safety of about 3. A modulus of rupture of 2500 pounds per square inch will be permitted in fir and yellow pine lumber, figured on actual size to lumber. A wind of 60 miles per hour gives a pressure of about $13\frac{1}{3}$ pounds per square foot on a vertical surface. On sloping roofs this figure is reduced in accordance with common practice.

On first thought it may seem that a factor of safety of 3 is too low. I am convinced, however, that the present styles of self-supporting roofs will not meet these requirements without some strengthening.

It is not hard to calculate the bending stresses at any point in a Gothic rafter. The method is to treat a pair of rafters as a three-hinge arch. This calculation shows that in a barn 36 feet wide with a wind of 60 miles per hour the maximum bending moment is about 2650 foot-pounds. This figure is for rafters two feet on centers and with a radius of about 27 feet. Knowing the bending moment we can decide how large a rafter is needed to resist that moment. The shearing strength of a built-up rafter cannot be calculated so easily and in the bent style of rafter particularly is the serious weakness. In other words, it is impossible to nail and bolt the pieces of a built-up rafter so well that they will not slip upon each other to some extent.

For a preliminary test four models of Gothic rafters were made. These were built as shown in Fig. 1 and were full size except for length. They were tested by a concentrated load applied at the center. Such a test produces severe shearing stresses, and this fact must be considered in interpreting results. The purpose of the rounding blocks at each support was to keep the span nearly the same regardless of deflection.

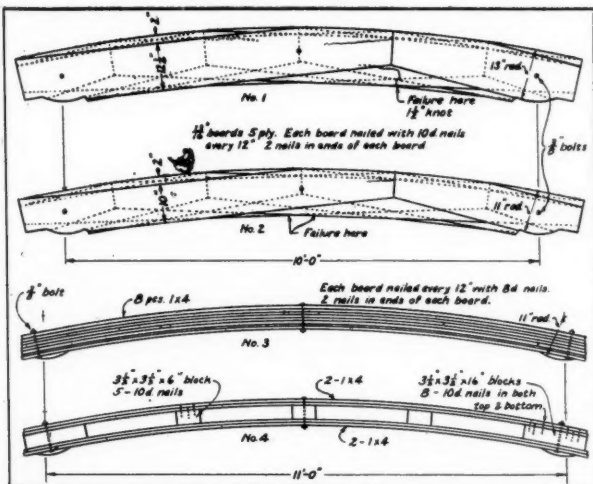


Fig. 1. The types of Gothic rafters used in the tests

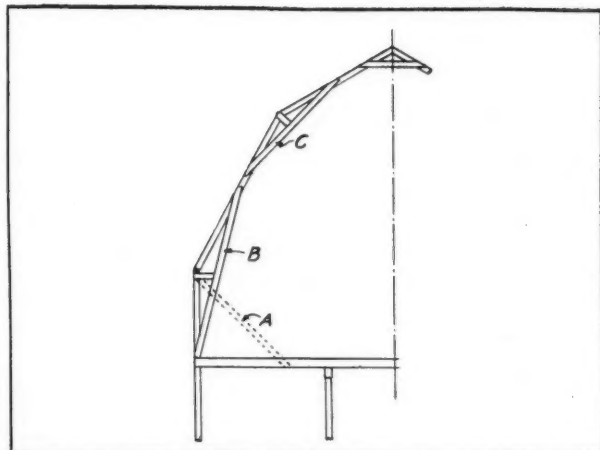


Fig. 2. Type of braced rafter roof in most common use

The blocks rested on smooth metal supports which were greased to eliminate arch action as much as possible.

The sawn rafters Nos. 1 and 2 failed at loads of 5800 and 6390 pounds, respectively. The bending moments at these loads were 14,500 and 15,975 foot-pounds. A 1½-inch knot on the lower edge of a board in No. 1 probably accounted for the fact that it did not test as strong as No. 2. The stiffness of both models was noticeable, the deflection in each case being about one inch shortly before failure.

Bent rafter No 3 was made in the usual way except that eight pieces, 1 by 4 inches were used. Probably it was better nailed than is customary. No. 4 was a skeleton rafter in which blocks were used along the center line. Both were loaded until they deflected 14 inches. At this point they were still taking load, but they were badly out of shape when the load was removed.

Deflection	Load Required to Produce Deflection	
	No. 3	No. 4
3 inches	360 pounds	440 pounds
4 "	400 "	540 "
6 "	530 "	630 "
8 "	650 "	740 "
10 "	800 "	820 "
12 "	970 "	930 "
14 "	1100 "	980 "

NOTE: The maximum strength was not determined.

To realize the significance of these tests it should be noted that a bending moment of 2650 foot-pounds was not reached until the load was over 1000 pounds. The outstanding feature of the bent rafters was their flexibility. Even a slight slippage between the pieces permitted considerable deflection and even small loads produced permanent deflections. It appears that it will be extremely difficult if not impossible to nail or bolt these rafters together well enough to overcome this difficulty. It is expected that further tests

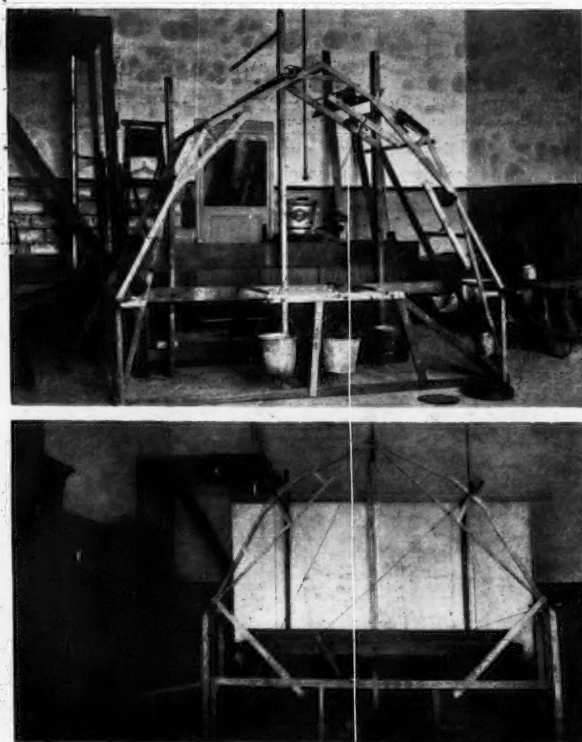


Fig. 3. (Above) A pair of braced rafters being tested
Fig. 4. (Below) The Iowa barn truss being tested
Loads were applied at plate, purlin, and ridge

will be made on full length rafters with distributed loading so that the shearing stresses will be more like they are in the actual construction. Such tests ought to be of much more value in deciding whether or not it is practicable to make bent rafters strong enough to meet our requirements. There seems to be no difficulty in making the sawn rafters of reasonable strength and the tests indicate that common practice in spacing them 6 to 8 feet apart has been surprisingly good. The bent rafters present problems more difficult to solve. The Gothic roof is popular among farmers, and we will do a real service by determining the most practical method of construction, considering strength, cost, etc.

In the past few years most plans for the braced rafter roof have been similar to Fig. 2 with the brace, A, omitted. Notice the absence of wind bracing in the barn below the plate when the brace, A, is not provided. If there is no partition to furnish this bracing the roof and ends must brace the entire barn in addition to carrying their own loads. A second objection to such construction is that it seems impossible to calculate the stresses in it with any degree of accuracy. So many assumptions must be made as to how the structure will act under load that calculations are of doubtful value.

In attempting to analyze the stresses in this construction I became convinced that it did not have the desired strength. Two tests were then made to see if this conclusion were true. Quarter-size models were tested as shown in Fig. 3. The pair of rafters under test is in the foreground. The pieces of iron hung at various points were added to give the proper dead load. The wind load was applied at right angles to the roof and wall by weights placed in the three pails, the right proportion being maintained at all times. After making proper allowance for the strength of lumber used in the models the tests indicated that the lower rafter on a 36-foot barn would break when the wind pressure reached about 24 pounds per square foot on a vertical surface. This would be under favorable conditions of bracing below the mow floor. If the roof had to brace the entire barn the failure would occur sooner. In these tests also there was a noticeable lack of stiffness in the construction. The models got badly out of shape under rather light loads.

My conclusion from these tests is that brace A is needed for two reasons:

1. To brace the barn below the plate against wind and relieve the roof of that duty. These braces spaced 10 or 12

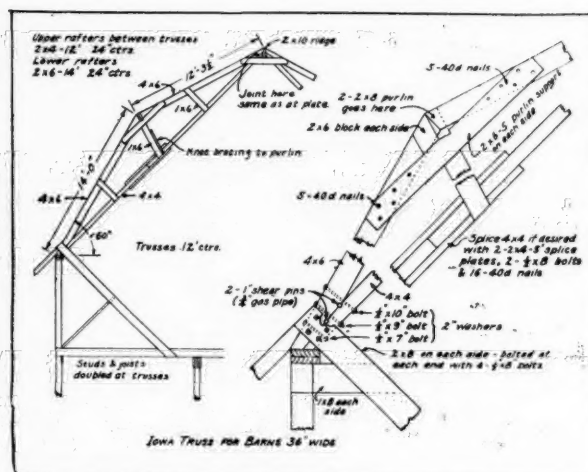


Fig. 5. The Iowa barn truss designed for a 60-mile-per-hour wind with a factor of safety of 3

feet apart use less lumber than braces B on every rafter and do their work much better.

2. If brace A is provided and brace B shortened or omitted we can then determine the stresses with reasonable accuracy and design with some intelligence. The three-hinge arch method can be applied, one hinge being at each plate and one at the peak. Then by using principles which are an old story to structural engineers we can obtain the bending moment and stress at any point along the rafter. We can determine the greatest tension in brace C so that we can specify how many nails are needed in each end. We can also decide how many bolts or nails are required in brace A. This in fact is what we expect to do. In revising our plans we expect to specify how many nails or bolts are to be

used in the principal joints. This is a vital feature of any plan and should not be left to the whim or fancy of the carpenter.

A number of attempts were made to study the stresses in the Shawver framing. When it appeared impossible to accomplish much along this line, an attempt was made to devise some changes in the Shawver truss. At last when no practical modification could be devised to make stress analysis possible it was decided to design a new truss. Two requirements were kept in mind: First, it must be a simple truss in which the stresses could be figured so that it could be designed intelligently for different widths, spacings, and loads; and second, it must be made of materials available.

(Continued on page 118)

Efficiency of Dust Separation in Air Cleaners for Internal Combustion Engines

By Arthur H. Hoffman

(Continued from the June issue)

PART III. THE CLEANERS TESTED

SOURCE. The manufacturer of every cleaner tested was invited to determine the size of his product to fit the engine on which the tests were to be run and to choose the particular cleaner to be tested. The manufacturers very generally availed themselves of this privilege.

NUMBER AND TYPES

In time for all tests	26
In time for power tests only	
(Nos. 24A, 25A, 25B, and 27)	4
Total	30

WATER TYPE	11
With float (Nos. 1, 2, 10, 11, 14, 24, and 24A)	7
Centrifugal principle (Nos. 8 and 27)	2
Atomizer principle (Nos. 15 and 16)	2

DRY TYPE	10
Centrifugal	8
Whirl produced by vanes (Nos. 6, 7, 23)	3
Whirl produced by vanes and ejected by use of exhaust gasses (Nos. 25A, 25B, 25)	3
Whirl produced by rotating member (Nos. 18, 19)	2
Cloth (Nos. 13, 17 and 17')	2

OIL TYPE	9
Filter of cloth (No. 9)	1
Filter of fibrous material (Nos. 3, 4, 26)	3
Filter of fibrous material and dry centrifugal (No. 5)	1
Filter of fibrous material and oil centrifugal (Nos. 21 and 22)	2
Filter of wire and oil centrifugal (No. 20)	1
Atomizer principle (No. 12)	1

METHODS OF DUST SEPARATION. (a) Water Type Cleaners with Float. Cleaners Nos. 1 (Fig. 15), 2, 10, 11, 14, 24 (Fig. 16), and 24A receive the dusty air through a tube usually passing up into the inside of a metal float. The air more or less finely divided by passing through screens or small perforations enters the water and in bubbling up loses most of its dust. Evidently the smaller the bubbles the better will be the chance for all dust particles to remain in the water. Baffle plates of various shapes are used to prevent

drops of water from passing out with the cleansed air and entering the carburetor intake. Some water, of course,

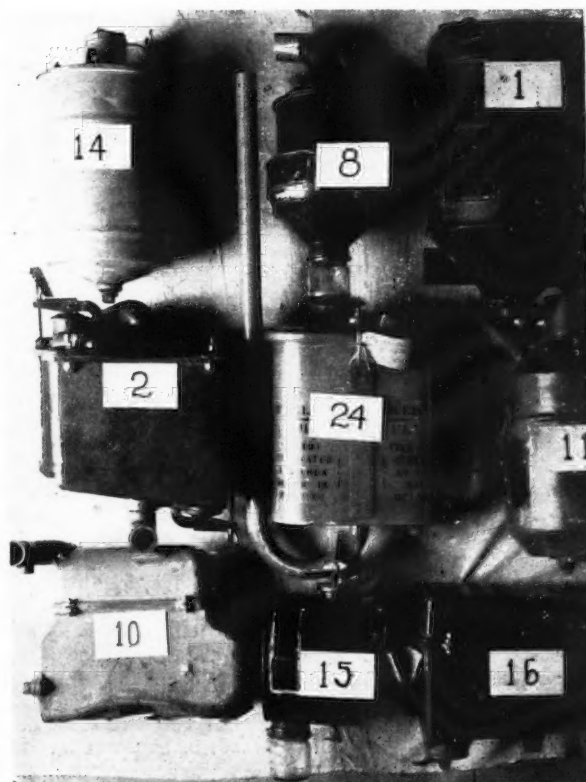


FIG. 12. WATER-TYPE CLEANERS

J. I. Case Threshing Machine Co., (1); Cleveland Tractor Co., (2); W. H. L. Donaldson, (8); Ford Motor Co. (Fordson), (10); International Harvester Co., (10-20 Titan), (11); Ross-Wortham Co. (R. W.), (14); Stewart-Warner Speedometer Corporation, (15); Tractor Appliance Co. (Taco Siphon), (16); Samson Tractor Co. (Model M), (24).

evaporates and passes in vapor form with the air into the engine. This vapor is generally advantageous in that it helps to prevent carbon formation and makes for smoother running. Water passing over in liquid form, if in appreciable quantity, causes irregular running, and may even cause the engine to stop. In some cases it may cause pistons to crack. (For effects of cleaners on power, see Fig. 35 and Table V.)

(b) Water-Type Cleaners Using Atomizer Principle. Cleaners Nos. 15 and 16 spray water in a finely divided state into the dusty air and later remove the dirty water from the air by use of baffle plates. The operation of No. 15 (Figs. 17 and 18) is much the same as that of a puddle-type carburetor, while that of No. 16 (Fig. 19) is somewhat like that of a multiple-jet carburetor.

(c) Water-Type Cleaners Using Centrifugal Principle. Cleaners Nos. 8 (Fig. 20), and 27 use metal vanes to guide the dusty air into circular motion while it is entering the water and to whirl the water, producing a spraying effect. The centrifugal effect and gravity are depended upon to remove both the moistened dust and the dirty water from the air passing through.

(d) Dry-Type Cleaners Using Centrifugal Principle. Cleaners Nos. 6, 7 (See "Note," Fig. 27), and 23 use tangential intake openings or curved guiding vanes, or both, to give the entering dusty air a whirling motion. The centrifugal effect and the force of gravity throw the dust against the walls of the cleaner and cause it to pass down into a receptacle in the base of the cleaner, while the cleansed air passes up from the center of the whirl and out by a tube from the top.

Cleaners Nos. 18 and 19 (Figs. 21 and 22) have a rotating device consisting of a small windmill caused to turn by the entering air and driving a set of radial vanes by means of which the centrifugal effect is obtained. In No. 18 the separated dust goes by gravity into a receptacle at the base of the cleaner. In No. 19 the separated dust together with a part of the air is ejected into the open air at the base of the cleaner, doing away with the need of cleaning out.

Cleaners Nos. 25 (Fig. 23), 25A and 25B use tangential inlet openings to give the entering dusty air a whirling motion. The combined action of centrifugal force, gravity and the suction of a jet air pump in the base of the cleaner throws the separated dust and a part of the air out again into the open, avoiding the necessity of cleaning out. The jet pump has no valves and operates on the same principle as the ejector much used for raising water against low heads. Here exhaust gas from the tractor engine operates the jet pump or expirator.

(e) Dry-Type Cleaners Using Filter Principle. Cleaners Nos. 13, 17, and 17' (Fig. 24) use dry cloth as the filtering medium. No. 13 has two metal frames, in the shape of the frustum of a cone, over the curved surfaces of which tubular cloths are tied. The removable top and bottom of the containing metal shell are heavily padded to make the ends of the cloth tubes air tight. The dusty air enters at the top near the center, passes sidewise through both cloths in succession and out at the side of the containing shell. A later model is said to have the direction of air through the cleaner reversed. This should give less vacuum. The size tested is designed for use on the Fordson tractor ahead of the regular water-type cleaner and the tests on it were run at Fordson load, except as otherwise noted. No. 17 as tested had two thicknesses of eiderdown blanketing (identical with that used in the "absolute cleaner" in the efficiency tests) over a cylindrical frame of 1/2-inch square mesh wire screen, the whole being enclosed in a cylindrical tin case. No. 17' is the same cleaner with the tin case open at one end or entirely removed. The case is not essential to its operation. The air passes slowly through the large area of cloth into the cylinder, and thence by a tube to the carburetor.

TABLE IV—IDENTIFICATION OF CLEANERS TESTED

No.	Make or Name	Type	WEIGHTS			INLETS		Size of body proper—ht., lgh., width	MATERIAL	
			Clean dry—lbs.	Ready for use—lbs.	Outlet Diam. inside—inches	Diam. inches size of opening	No.		Body	Filter (if any)
1	Case	Wet	18 3/4	39 1/4	2 1/2	1	2 1/2	19 1/2 x 12 1/2	Sheet metal	
2	Cleveland	Wet	57 3/4	74 1/2	1 1/2	1	1 1/2	14 x 13 x 9	Cast	
3	Dalley	Oil	11 3/4	12	1 3/4	1	1 7/8	18 x 7 1/2 D	Sheet metal	Fiber
4	Dalley	Oil	12	12 1/4	1 7/8	1	1 7/8	18 x 10 D	Sheet metal	Fiber
5	Donaldson	Oil & dry	5 3/4	5 3/4	1 3/4	15	1 1/4 x 3/4	16 x 8 D	Sheet metal	Fiber
6	Donaldson	Dry	5 1/4	5 1/4	2 1/4	1	2 1/4	12 x 11 D	Sheet metal	
7	Donaldson	Dry	2	2	2	15	1 x 1 1/4	11 1/4 x 8 D	Sheet metal	
8	Donaldson	Wet	15	10	1 7/8	1	1 3/4	17 x 9 D	Sheet metal	
9	Fageol	Oil	9 1/4	9 1/2	1 1/2	1	1 1/2	13 3/4 x 10 3/4 D	Sheet metal	Cloth
10	Fordson	Wet	40 1/4	53 1/4	1 3/4	1	1 1/2 x 1 1/2	12 x 14 1/2 x 6	Cast	
11	I. H. C.	Wet	18	34	2	1	2 1/2	18 1/2 x 10 1/2 D	Cast & sheet	
12	Palmer	Oil	9 1/2	15	1 1/8	1	1 x 3	18 x 8 1/2 D	Sheet metal	
13	Success	Dry	10 1/2	10 1/2	1 7/8	1	1 7/8	15 x 8 D	Sheet metal	Cloth
14	R. W.	Wet	8 3/4	18 1/2	1 3/8	6	1	15 x 9 D	Sheet metal	
15	Stewart-Warner	Wet	7	16 1/4	1 3/8	2	1 3/4 x 2	13 x 9 1/2 x 6 1/2	Sheet metal	
16	Taco Siphon	Wet	41 1/2	56	2	1	2 1/2	12 1/2 x 16 x 7 1/2	Cast	
17	Eiderdown (closed)	Dry	9	9	1 3/8	1	2	26 x 12 1/2 D	Sheet metal and screen	Cloth
17'	Eiderdown (open)	Dry	5	5	1 3/8	1	565 sq. in.	19 x 10 D	Sheet metal and screen	Cloth
18	United collector	Dry	8 3/4	8 3/4	1 1/2	1	1 1/2	10 1/2 x 5 D	Cast	
19	United ejector	Dry	2 1/2	2 1/2	1 3/8	1	3/4	7 x 5 D	Cast	
20	Pomona	Oil	4	5 3/4	2	1	2	13 1/2 x 4 1/2 D	Sheet metal	Wire
21	Pomona	Oil	3 1/4	5	2	1	2	13 x 4 1/2 D	Sheet metal	Fiber
22	Pomona	Oil	9	16 1/2	2	1	2 1/2	15 x 10 D	Sheet metal	Fiber
23	Bennett	Dry	4 1/4	4 1/4	1 3/4	3	1 1/8	9 x 6 D	Sheet metal	
24	Samson	Wet	27 1/4	42 1/2	1 3/8	1	1 3/8	14 x 12 1/2 x 7	Sheet & cast	
24A	Samson	Wet	28 1/4	37 1/4	1 1/4	1	2 x 6 1/2	15 x 10 D	Sheet & cast	
25	Stromberg	Dry	3 1/2	3 1/2	1 3/8	12	7/8 x 3/4	14 x 6 D	Spun & cast	
25A	Stromberg	Dry	3 1/2	3 1/2	1 3/8	12	7/8 x 3/4	14 x 6 D	Spun & cast	
25B	Stromberg	Dry	4 3/4	4 3/4	1 3/8	12	1 1/8 x 3/4	16 x 7 1/2 D	Spun & cast	
26	Dalley	Oil	10	10 1/2	1 3/8	1	1 3/4	17 1/2 x 10 D	Sheet metal	Fiber
27	Bennett	Wet	8 1/4	15 1/4	1 3/4	1	1 3/4	12 x 9 D	Sheet metal	

(f) Oil-Type Cleaners Using Filter Principle. Cleaners Nos. 3, 4, and 26 (Fig. 25) pass the dusty air through a filter consisting of layers of fibrous material saturated with oil. The oily mud is removed from the filter by flushing out with kerosene or distillate, after which the filter must be reoiled.⁴

⁴Refuse oil drained from the crankcase may be used satisfactorily for any of the oil-type cleaners tested. The oil before being used for this purpose should stand for a few days to allow the coarser dirt to settle out.

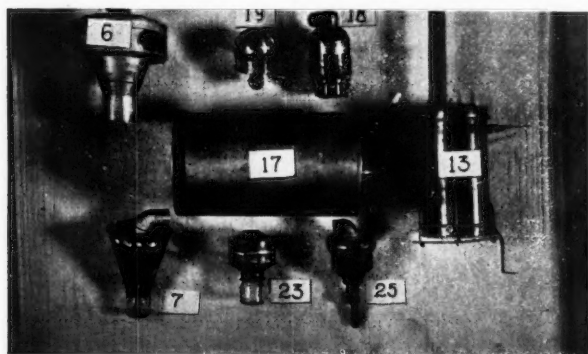


FIG. 13. DRY-TYPE CLEANERS
Donaldson Co., Inc. (15-hp. tractor), (6); Donaldson Co., Inc. (7); Liljegren & Dugain ("Success" for Fordson), (13); copied from eiderdown cleaner shown in *Chilton Tractor Journal*, June, 1919, p. 11, (17); United Manufacturing and Distributing Co. (collector type), (18); United Manufacturing and Distributing Co. (ejector type), (19); Bennett Carburetor Co., (23); Stromberg Motor Devices Co., (25)

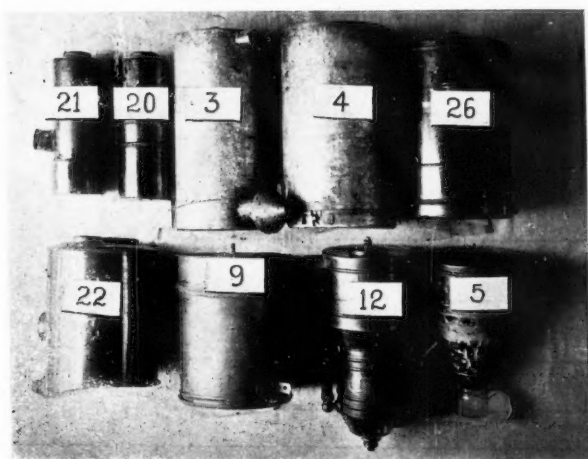


FIG. 14. OIL-TYPE CLEANERS
Dailey Bros., (3); Dailey Bros., (4); Donaldson Co., Inc., (5); Fageol Motors Co., (9); A. E. Palmer (experimental), (12); Vortex Manufacturing Co. (Pomona), (20); Vortex Manufacturing Co. (Pomona), (21); Vortex Manufacturing Co. (Pomona), (22); Dailey Bros. (Model 1), (26)

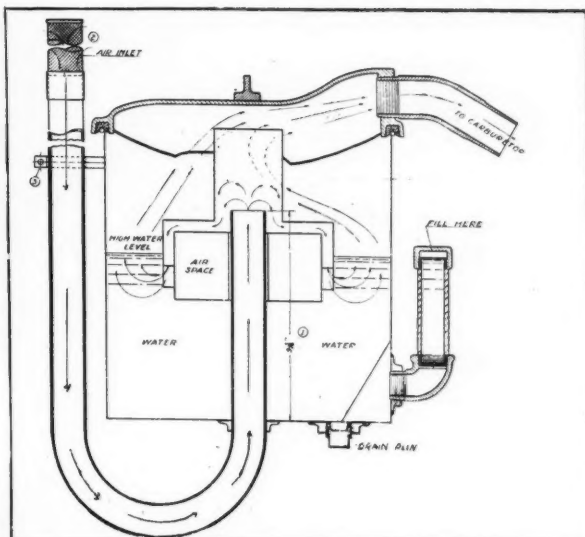


FIG. 16. SAMSON AIR CLEANER
Section of cleaner No. 21. Float type, air drawn through water

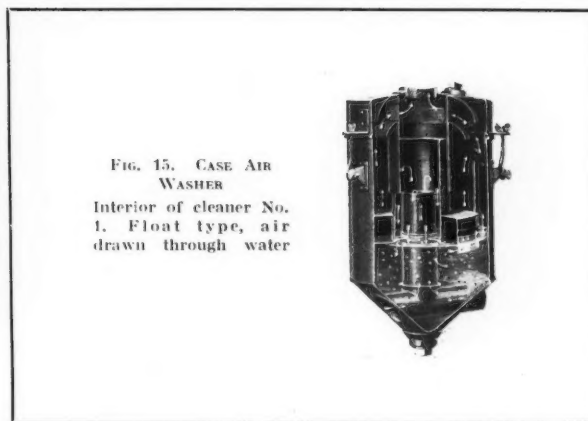
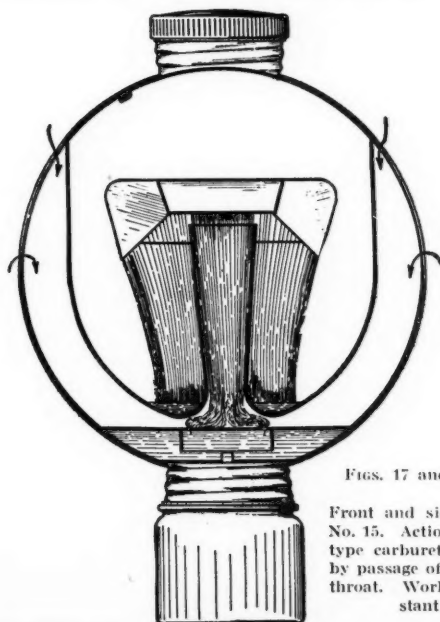


FIG. 15. CASE AIR WASHER
Interior of cleaner No. 1. Float type, air drawn through water



FIGS. 17 and 18. STEWART-WARNER AIR CLEANER
Front and side views, interior of Cleaner No. 15. Action is similar to that of puddle-type carburetor, the water being atomized by passage of dusty air through the narrow throat. Working level of water kept constant by pneumatic action

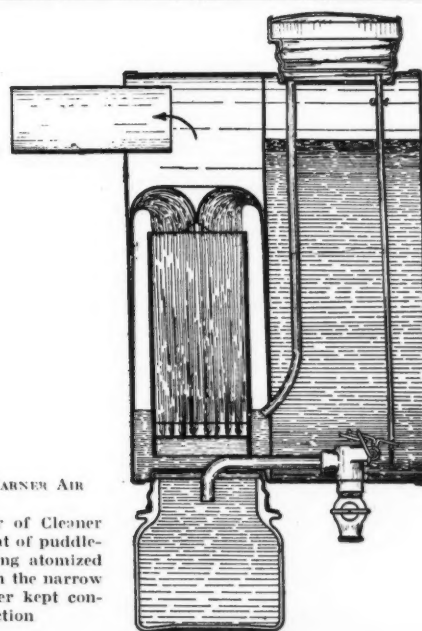


TABLE V—SUMMARY OF TESTS

No.	Make or trade name	Av. —all tests	Service run	Low water or oil	Vacuum		Cleaner out after tests	Maximum power cleaner on	Ratio, hp. with cleaner off—per cent
					At 20.4 hp. 1200 r.p.m.—inches water	At maximum horsepower 1200 r.p.m.—in. water			
1	Case	96.0	96.1	95.2	1%	1 1/4	2.6	27.0	100.0
2	Cleveland	89.3	85.8	83.6	3 1/2	5 1/2	8.5	26.6	98.7
3	Dalby	99.5	99.9		6 1/2	12	10.7	26.6	98.7
4	Dalby	90.8	90.9		5 1/2	12	10.7	26.6	98.7
5	Donaldson	97.8	98.0		3 1/2	20 1/2	4.5	27.2	100.6
6	Donaldson	74.7	67.4		1 1/2	2 1/2	3.8	27.1	100.3
7	Donaldson	51.0	50.3		2 1/2	2 1/2	4.2	27.1	100.2
8	Donaldson	96.7	97.3	95.0	2 1/2	2 1/2	7.4	27.0	100.0
9	Fageol	98.5	99.5		4 1/2	16	12.8	25.7	95.2
10	Fordson	88.9	89.8	85.5	7 1/2	14	3.3	26.8	99.3
11	F. H. C.	94.6	94.4	92.3	2 1/2	2 1/2	3.5	27.4	101.7
12	Palmer	96.6	96.9	94.7	4	6	6.3	26.9	99.6
13	Success	98.7	97.8		1 1/2	2 1/2	2.2	27.0	99.9
14	R. W.	93.1	92.6	92.6	3 1/2	27 1/2	8.3	26.9	99.7
15	Stewart-Warner	95.7	95.8	Const. level	4 1/2	5 1/2	11.1	26.5	98.3
16	Taco siphon	92.4	94.0	88.9	2 1/2	3 1/2	5.8	27.0	99.8
17	Elderdown (closed)	99.4	99.5		2 1/2	2 1/2	5.6	27.2	100.7
17	Elderdown (open)	Test not run					4.8	27.0	99.9
18	United (collector)	73.3	72.5		9	9	12.7	26.5	98.2
19	United (ejector)	62.2	58.3		3 1/2	4 1/2	9.3	27.0	99.8
20	Pomona	98.4	98.2		2 1/2	2 1/2	7.2	26.7	98.8
21	Pomona	98.8	98.6		2 1/2	2 1/2	5.3	27.5	102.0
22	Pomona	97.4	97.1		1 1/2	1 1/2	4.8	26.6	98.3
23	Bennett	42.7	37.6		5 1/2	6 1/2	8.9	26.6	98.2
24	Samson	95.9	95.2—Not run	5 1/2	5 1/2	10.1	10.1	27.0	100.1
25	Stromberg	88.5	87.4		4 1/2	6 1/2	11.1	26.5	98.3
25A	Stromberg						8.8	26.4	97.6
25B	Stromberg						7.9	27.2	100.6
26	Dalby	99.7	99.6		8 1/2	9	17.4	26.7	98.9
27	Bennett						9.3	26.8	99.1

*Abnormal, chaff of chaff test not all out.

TABLE VII—SUMMARY OF FILL-UP TESTS

Cleaner No.	Test run No.	Length run—min.	Brake hp.	Room temp. °F.	Dust No. 1—lb.	Dust caught in cleaner—lb.	Water or oil going over—lb.	Vacuum due to cleaner—Inches water	Rate of air flow—cu. ft. per min.	Note
1	111	18	20.4	104	9	1 1/2	0	17 1/2	53	1
2	102	54	20.4	91	5	1 1/2	0	17 1/2	53	2
5	71	31	20.4	83	50	1	0	7 1/2	20 1/2	3
9	22		20.4	78	(gram)	(gram)		6 1/2	26 1/2	4
10	108	28	16	98.7	5	0.16	0	1 1/2	2 1/2	5
13	16	8	16	82	5	0.16	0	11 1/2	24 1/2	6
15	68	36	20.4	67	3	.25	0	5 1/2	16 1/2	7
16	59	58	20.4	83	5	.02	0	2 1/2	5 1/2	8
17	128	23	20.4	92	5	**	0	3	4-17/32	9
20	76	18	20.4	95	2.5	**	0	2 1/2	3 1/2	10
21	33	30	20.4	76	3	1	0	2 1/2	14 1/2	11
22	81	36	20.4	100	7	1	0	1 1/2	3 1/2	12
24	38	56	20.4	86	5	1/2	Trace	4 1/2	26 1/2	13
26	57	62	20.4	76	5	**	0	8 1/2	10	14

NOTES:

- One pound sand, etc., found in horizontal inlet tube in base of cleaner at close of test. Dust of previous runs (200 grams) left in.
- Cleaned out before test.
- Dust of previous run (100 grams) left in. Not deemed necessary to use any No. 2 Standard dust.
- Dust of previous runs (100 grams) left in.
- Dust of previous runs (200 grams) left in. Tested at Fordson load.
- Dust of previous runs (100 grams) left in.
- Dust of previous runs (150 grams) left in.
- Dust of previous runs (250 grams) left in.
- Dust of previous runs (150 grams) left in.
- Dust of previous runs (150 grams) left in. Dust going through rather freely after fourth half pound dust in.
- Dust of previous runs (200 grams) left in. Sand began passing to trap soon after oil ceased to spray.
- Dust of previous runs (150 grams) left in.
- Cleaned out before this test.
- Dust of previous runs (150 grams) left in. Amount abnormal since rapid rate of dust feed raised water level about 1/2 inch above high mark.
- Not weighable on 1/4-oz. sensitive scale.
- Not weighed.
- Cubic feet per minute, 60° F. and 14.7 pounds per square inch.

In Cleaner No. 9 (Fig. 26) the dusty air passes into a metal shell surrounding a conical tube of cotton cloth saturated with oil. In practice the oily condition of the cloth is maintained by a fine vapor of oil coming from the crankcase through the breather pipe. The accumulated dirt in the cloth is removed by rinsing in kerosene or distillate, after which the cloth is drained, reoiled and replaced.

Cleaner No. 5 (Fig. 27) combines the usual Donaldson dry centrifugal (Nos. 6 and 7) with a ring-shaped filter of oiled fibers.

Cleaner No. 20 uses a filter of fine wire and Cleaners Nos. 21 (Fig. 28), and 22 fibrous filters kept cleaned and oiled

TABLE VI—SUMMARY OF CHAFF TESTS

(Ten grams dry wheat chaff was fed to cleaners not having adequate screen, to find effect on vacuum.)

Cleaner No.	1	5	8	10	17	20	24	25
Run No.	113	72	129	107	137	77	37	58
Length run, min.	10	11	30	8	8	47	33	43
Brake hp.	20.4	20.1	20.4	16	20.4	20.4	20.4	20.4
Rate of air flow, cu. ft. per min., 60° F. and 14.7 lbs. per sq. in.	53	54	53	47	53	54	55	54
Vacuum due to cleaner—								
Min.	1 1/2	3 1/2	4 1/2	1 1/2	2 1/2	2 1/2	5 1/2	9 1/2
Max.	1 1/2	3 1/2	10 1/2	1-5/32	2 1/2	6 1/2	32 1/2	28 1/2
Remarks:	Note 1	Note 2	Note 3	Note 4	Note 5	Note 6	Note 7	Note 8

NOTES:

- Dust (170 grams) of previous runs left in.
- Filter cleaned out and reoiled before test.
- Drained out (but not flushed) and refilled before test.
- Dust (200 grams) of previous runs left in. Water level low.
- Dust (150 grams) of previous runs left in.
- Filter cleaned out and reoiled before this test.
- Dust (150 grams) of previous runs left in. No. 24A (received too late for test) has an adequate screen.
- Dust (150 grams No. 1 Standard and 5 pounds No. 2 Standard) from previous runs left in.

TABLE VIII. DATA OF DUST SEPARATION EFFICIENCY TESTS

(Sample table; complete data for all cleaners tested on file at the office of the Department of Agricultural Engineering, University Farm, Davis, California.)

Tested Cleaner No. 8, W. H. L. Donaldson Air Washer.

Run No.	123	124	125	126	127	128	129
Length of run, min.	32	32 1/2	35.5	31	27 1/2	25 1/2	30
Brake hp.	12.6	20.4	20.4	20.4	20.4	20.4	20.4
Dust used, Std. No. 1, grams	50	50	50	50	50	50 (y)	0
Dust caught by absolute cleaner, grams	1.43	.96	2.48	1.30	2.59	0.46 (y)	—
Efficiency of tested cleaner	97.1	98.1	95.0	97.3	94.8	99.1 (y)	—
Water or oil going over from cleaner, grams	0	0	0	4	0	0	0
Vacuum at inlet of cleaner, inches water							
Min.	1 1/2	3 1/2	3 1/2	3 1/2	7 1/2	2 1/2	4 1/2
Max.	1 1/2	3 1/2	3 1/2	3 1/2	7 1/2	2 1/2	4 1/2
Vacuum due to cleaner, inches water							
Min.	3	4 1/2	2 1/2	4 1/2	2 1/2	2 1/2	1 1/2
Max.	3 3/32	4 1/2	2 1/2	4 1/2	2 1/2	2 1/2	1 1/2
Rate of air flow, cu. ft. per min., 60° F. and 14.7 lbs. per sq. in.	43	53	53	53	53	53	53
Room temp., deg. F.	93.3	81	85	88	89	90	90
Temp. leaving cleaner	74	67.7	73.7	76.7	76	79	—
Humidity, entering cleaner	38	55	46	46	35	26	—
Humidity, leaving cleaner	81	85	73	81	62	55	—
Conditions of test	(h)	(a)	(d)	(c)	(x)	(v)	(e)

REMARKS:

- Normal load, normal speed, quick dust feed. Water level high, dust of Run 123 left in.
- Light load, normal speed, quick dust feed. Water level high.
- Service run, variable load, variable speed, backfire, etc. Readings taken at normal load and speed. Water level high. Dust of Run 125 left in.
- Normal load and speed, water level low (2 1/2 pounds water in). Cleaner drained out but not flushed before run. Quick dust feed.
- Chaff test. Water high.
- Duplicate of Run 125 for check. Different men operated engine.
- Same as Run 127 except dust used was 1.38 times as dense as the No. 1 Standard. Hence efficiency given is not official.

NOTE: Water required to fill 5 pounds. In Service Run 126 about 4 grams of dirty water in trap. Net dry residue 0.19 gram. This cleaner should have a more obvious place for filling with water.

by spray from oil in a cup at the base of the cleaner. The spray is due to the oil being whirled by the air entering at a tangentially placed opening. This spray of oil accounts for the nearly constant vacuum observed in the efficiency tests of these cleaners.

(g) Oil-Type Cleaner Using Atomizer Principle. Cleaner No. 12 (Fig. 29) has a narrow Venturi throat through which the dusty air passes and where the oil, entering through holes in the sides of the throat, is torn into a fine spray. The air encounters a baffle of inverted cup shape which separates the oil from the air and returns it to the oil reservoir. A wire screen is designed to assist in removing the oil from the air.

PART IV. RESULTS OF TESTS

SUMMARIES. A general summary is given in Table V, of chaff tests in Table VI, and of fill-up tests in Table VII.

Table VIII is given as a sample representative of the twenty-six summaries of tests on individual cleaners. A list of notes taken from the test records is also given. Table IX gives the results of chemical analyses made to determine the efficiency of the cleaners in removing abrasive material from the entering dusty air. Since top cloth only was analyzed,

the results are slightly in error in favor of the less efficient cleaners.

PHOTOGRAPHIC COMPARISON OF EFFICIENCY. The top cloths of the absolute cleaner used in the service runs on the several cleaners were grouped by types and photographed. Figs. 30, 31, and 32 show these cloths for the wet, dry and

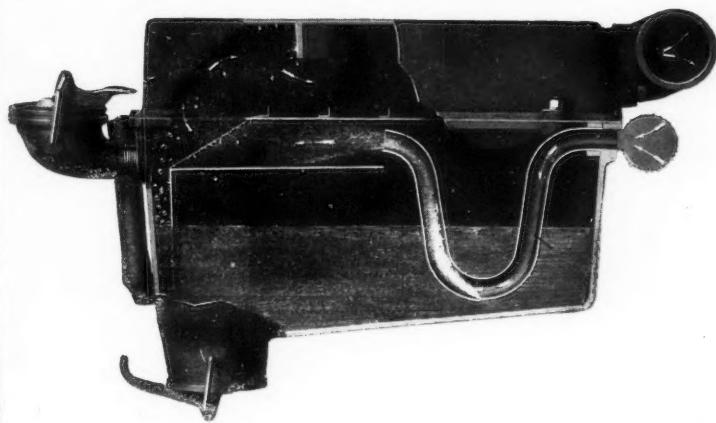


FIG. 19. Two "Siphon" Air Washer
Interior of Cleaner No. 16. Principle similar to that of jet carburetor. Water entering by small openings at bottom of U is atomized by passage of stream of dusty air

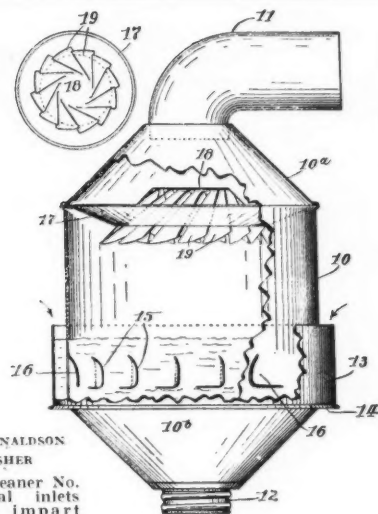


FIG. 20. DONALDSON
AIR WASHER

Interior of Cleaner No. 8. Tangential inlets and vanes impart whirling motion to entering air and to water. Baffle vanes above remove water drops from cleansed air

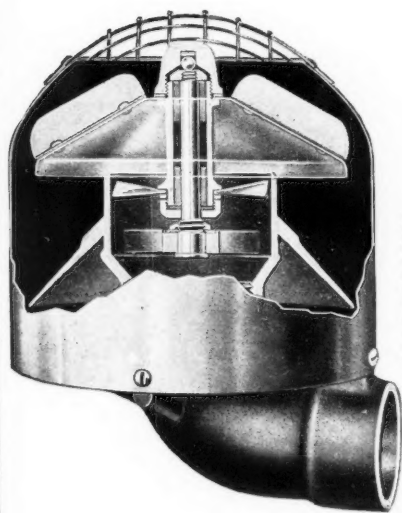


FIG. 21. UNITED
EJECTOR AIR
CLEANER

Showing Cleaner No. 19, interior construction. A small windmill in the intake tube drives a set of radial vanes which whirled the air and dust, throwing out the dust and some of the air at the edges of the skirt

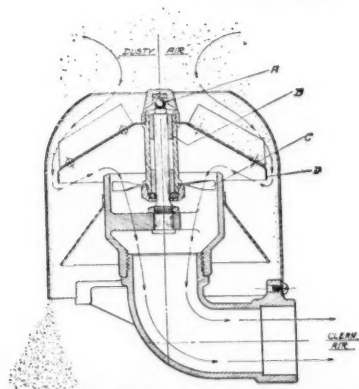


FIG. 22. UNITED EJECTOR AIR CLEANER
Section showing operation of the cleaner of Fig. 21

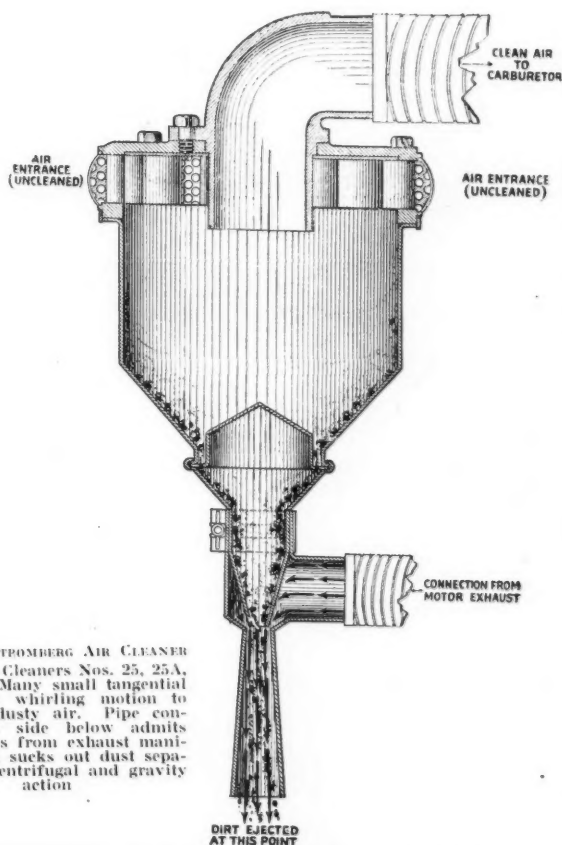


FIG. 23. STROMBERG AIR CLEANER
Interior of Cleaners Nos. 25, 25A, and 25B. Many small tangential inlets give whirling motion to incoming dusty air. Pipe connection at side below admits blast of gas from exhaust manifold which sucks out dust separated by centrifugal and gravity action

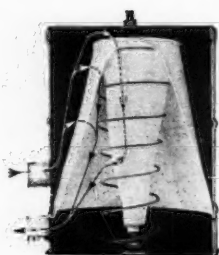


FIG. 26. FAGEOL AIR CLEANER

Interior of Cleaner No. 9. Cone of oiled cotton cloth gripped at edges between upper and lower parts of metal shell. Held in position by rod and heavy spiral spring

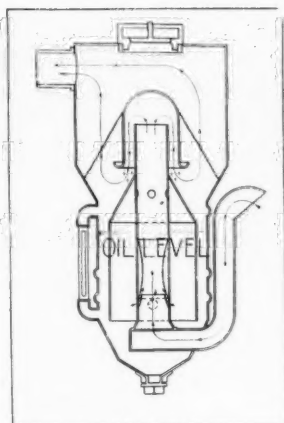


FIG. 29. PALMER AIR CLEANER
Interior of Cleaner No. 12. Atomizes the oil as a carburetor having multiple openings in its Venturi throat atomizes gasoline. Baffles return the dirty oil to reservoir



FIG. 27. DONALDSON COMBINATION

Dry centrifugal cleaner and oily fiber filter. Interior of Cleaner No. 5. (Note: The lower part of this cleaner is the same construction as cleaners Nos. 6 and 7.)

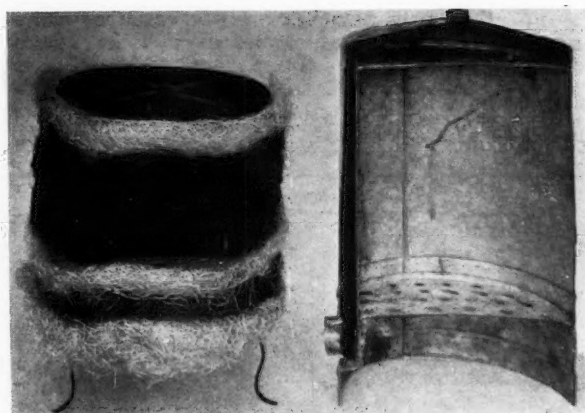


FIG. 25. DAILEY AIR CLEANER

Interior of Cleaners Nos. 3, 4, and 26. Certain fibers are used packed in a metal shell. Some coarse dirt caught in oil drip pan (not shown). Fine dust caught in passing through filter of oily fibers

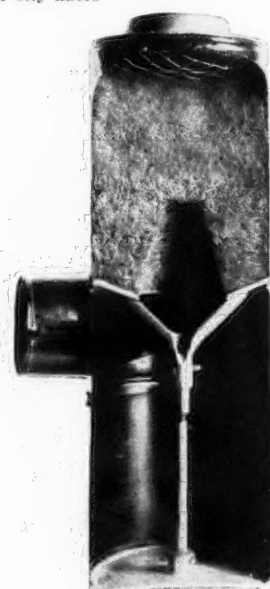


FIG. 28. POMONA AIR CLEANER
Interior of cleaners Nos. 20 and 21. Dusty air entering oil cup by tangential opening whirls oil and sends up spray to filter, washing same and keeping vacuum effect practically constant. Filter may be either of wire or organic fibers

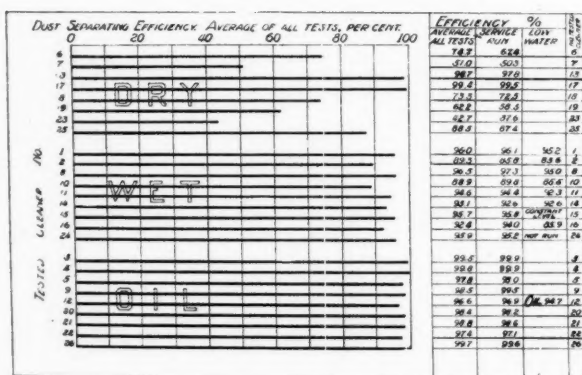


FIG. 33. Graph of dust-separation efficiency

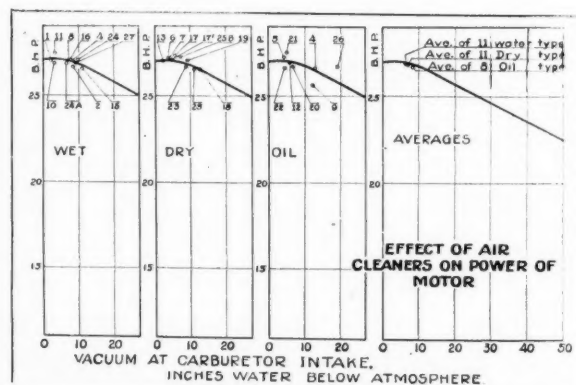


FIG. 35. Graph showing effect of air cleaners on power of engine

oil-type cleaners, respectively. Uneven lighting in the case of the oil type photo makes it slightly misleading. Accurate comparison may be had by reference to the efficiency graph (Fig. 33), and to the summary of tests (Table V).

GRAPHS. Fig. 33 shows graphically the dust-separation efficiencies and enables comparison among the types as well as among individuals. Fig. 34 enables a similar comparison with respect to vacuum, and Fig. 35 with respect to the effect of the cleaners on the power of the engine.

NOTES TAKEN FROM THE TEST RECORDS

(See also notes in tables of summaries.)

Cleaners Nos. 3, 4, and 26 (Dailey). The intake cone furnished regularly with this cleaner *was not in position* during any of the tests. Its effect would be to increase efficiency and vacuum slightly and to lengthen slightly the time between clean-outs. The vacuum in Cleaner No. 4 measured by 18 inches of water (read when 150 grams No. 1 standard dust had been fed in) dropped to 10 $\frac{3}{8}$ inches when the cleaner was jarred with a wooden mallet.

Cleaner No. 6 (Donaldson Dry). This cleaner is designed for a larger engine than the 25 hp. machine used in the tests. After the runs on this cleaner, a large quantity of dust was found in the shroud of the cleaner. This makes the efficiencies found higher than they would be after runs enough to fill free space in shroud.

Cleaner No. 8 (Donaldson water type). (See Table VIII

which is given as a sample typical for all cleaners.)

Cleaner No. 12 (Palmer). A trace of oil in very finely divided form was found on top cloth of absolute cleaner after each test. When motor idles or stops, oil settles into air intake tube in such quantity as to cause "choking" of carburetor. This vacuum (fluctuating about 1 $\frac{1}{4}$ inches of water) might cause trouble in starting a warm engine.

Cleaner No. 15 (Stewart-Warner). At end of dust feeding in fill-up test, vacuum due to cleaner was 16 $\frac{1}{8}$ inches of water. After 7 minutes longer run without more dust, vacuum decreased to 14 $\frac{13}{16}$ inches. One side of cleaner was almost completely clogged due to the rapid rate of feeding. Some iron oxide present in the cleaner may have been in part to blame for the clogging. (Later models are of brass instead of terne plate, obviating this difficulty).

Cleaner No. 19 (United ejector). A test of bearing life was run on this cleaner, 25 cubic feet per minute air drawn through by vacuum cleaner. Time, 216 hours before the efficiency tests, 315 hours after. Total 531 hours. Cleaner chattered a good deal toward close of test.

Cleaner No. 23 (Bennett dry). Run No. 64 discarded as official service run, but averaged with Runs 62 and 63 since dust from previous runs (Nos. 62 and 63) probably came loose from interior walls of cleaner and passed on to absolute cleaner. If cleaner had been shaken during and at close of Runs 62 and 63 this dust would have reduced their efficiencies. Dust (dry) removed from cleaner after Runs 62, 63, and 64, totals 61.9 grams.

Cleaner No. 25 (Stromberg ejector). With normal load and speed and with cleaner outlet and inlet disconnected from other apparatus and closed, expirator produced a vacuum, inside of cleaner body, measured by 12 $\frac{3}{8}$ inches of water.

Pressure of exhaust gas in pipe 1 inch from cleaner was 11 $\frac{1}{2}$ inches of water average during first tests on this cleaner.

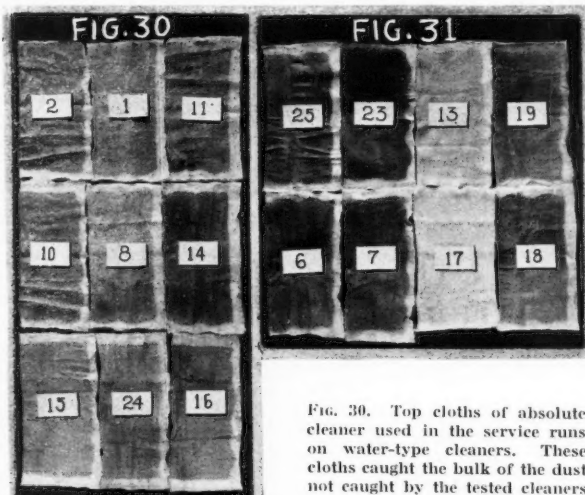


FIG. 30. Top cloths of absolute cleaner used in the service runs on water-type cleaners. These cloths caught the bulk of the dust not caught by the tested cleaners

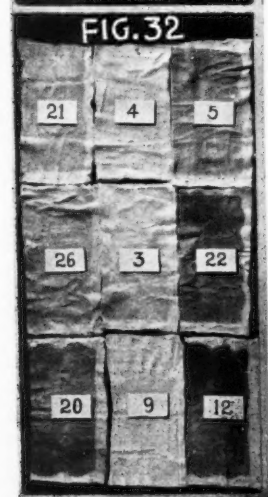
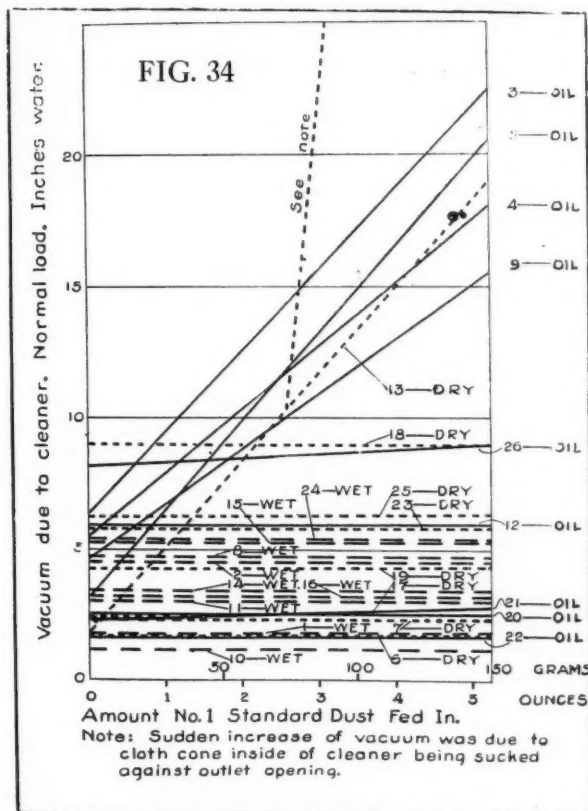


FIG. 31. Top cloths of absolute cleaner used in the service runs on dry-type cleaners. The contrast between dusty central portions and clean edges where clamped between frames gives indication of the relative efficiencies

FIG. 32. Top cloths of absolute cleaner used in the service runs on oil-type cleaners. (Uneven lighting makes this photo slightly misleading. See efficiency graph, Fig. 33, for accurate comparisons.)

FIG. 34. Graph showing how amount of dust in cleaner affects the vacuum



During the last tests it was about $4\frac{1}{2}$ inches. The difference is due probably to a slight change in the point in exhaust manifold where gas for the cleaner was piped out. It is interesting to note that the cleaning efficiency is unchanged. After the seven runs, there was found a carbon deposit about $1/32$ -inch thick in the throat of the expirator.

TABLE IX. ANALYSES OF TOP CLOTHS* OF ABSOLUTE CLEANER USED IN SERVICE RUNS

Cleaner No.	Cloth plus dust (dry)—grams	Total ash from cloth plus dust—grams	Insoluble ash from total ash—grams**	Per cent total abrasive caught by cleaner	Cleaner No.
1	26.4	.644	.545	97.7	1
2	29.2	2.081	1.943	91.3	2
3	29.2	.129	.039	99.8	3
4	29.5	.146	.025	99.9	4
5	32.3	.456	.350	98.4	5
6	35.0	6.847	6.415	70.6	6
7	39.4	9.085	8.613	60.5	7
8	28.6	.327	.237	99.0	8
9	30.7	.165	.025	99.9	9
10	30.6	1.835	1.676	92.5	10
11	29.8	.990	.880	96.0	11
12	28.5	.523	.422	98.1	12
13	31.7	.459	.246	98.9	13
14	30.9	1.145	.998	95.5	14
15	29.5	.791	.768	96.6	15
16	32.9	1.071	.964	95.7	16
17	27.1	.116	.046	99.7	17
18	32.3	4.867	4.551	79.3	18
19	37.6	6.775	6.482	70.3	19
20	29.2	.296	.189	99.2	20
21	32.0	.332	.121	99.5	21
22	30.3	.498	.393	98.3	22
23	42.0	12.225	11.629	46.7	23
24	29.6	.570	.457	98.0	24
25	31.1	2.134	1.974	91.2	25
26	28.7	.187	.080	99.6	26

A piece of clean, unused cloth weighing (dry) 100 grams yielded 0.27 gram total ash and 0.031 gram insoluble ash from total ash.

*Approximate halves of the top cloths of absolute cleaner used in the service runs were sent to the Division of Plant Nutrition, University of California, Berkeley, where these analyses were made by the courtesy of Prof. P. L. Hibbard.

**"This acid-insoluble residue is largely mineral matter which is not readily decomposed by treatment with hydrochloric acid. I should regard it as practically the abrasive material."—From letter of Prof. Hibbard accompanying his report.

APPENDIX

TABLE X. NAMES AND ADDRESSES OF MANUFACTURERS OF AIR CLEANERS USED IN CALIFORNIA TESTS

- BENNETT (Nos. 23 and 27)—Bennett Carburetor Co., 101-103 First Ave., North, Minneapolis, Minn.
- CASE (No. 1)—J. I. Case Threshing Machine Co., Racine, Wis., and San Francisco, Calif.
- CLEVELAND (No. 2)—Cleveland Tractor Co., Cleveland, Ohio, and 147 New Montgomery St., San Francisco, Calif.
- DAILEY (Nos. 3, 4, and 26)—Dailey Bros., Reedley, Calif.
- DONALDSON (Nos. 5, 6, and 7)—Donaldson Company, Inc., 693 Raymond Ave., St. Paul, Minn.
- DONALDSON Air Washer (No. 8)—W. H. L. Donaldson, 988 Cromwell Ave., St. Paul, Minn.
- EIDERDOWN (No. 17)—Made by local tinsmith, Davis, Calif., following cut and description in *Chilton Tractor Journal*, June 1, 1919, p. 41.
- NOTE: No. 17' is No. 17 without a cover.
- FAGEOL (No. 9)—Fageol Motors Co., Oakland, Calif.
- FORDSON (No. 10)—Ford Motor Co., Detroit, Mich.
- I. H. C. (No. 11)—International Harvester Co., Chicago, Ill., and 201 Potrero Ave., San Francisco, Calif.
- PALMER (No. 12)—A. E. Palmer, 1610 Elberon Ave., East Cleveland, Ohio.
- POMONA (Nos. 20, 21, and 22)—Vortex Mfg. Co., Pomona, Calif.

R. W. (No. 14)—Ross-Wortham Co., 641 Fulton St., Chicago, Ill.

SAMSON (Nos. 24 and 24A)—Samson Tractor Co., Janesville, Wis., and Stockton, Calif.

STEWART-WARNER (No. 15)—Stewart-Warner Speedometer Corporation, 1826-1852 Diversey Blvd., Chicago, Ill.

STROMBERG (Nos. 25, 25A, and 25B)—Stromberg Motor Devices Co., 58-68 East 25th St., Chicago, Ill.

SUCCESS (No. 13)—Liljegren & Dugain, Arbuckle, Calif.

TACO SIPHON (No. 16)—Tractor Appliance Co., New Holstein, Wis.

UNITED (collector and ejector, Nos. 18 and 19)—United Mfg. & Distributing Co., Ohio St. and Lake Shore Drive, Chicago, Ill.

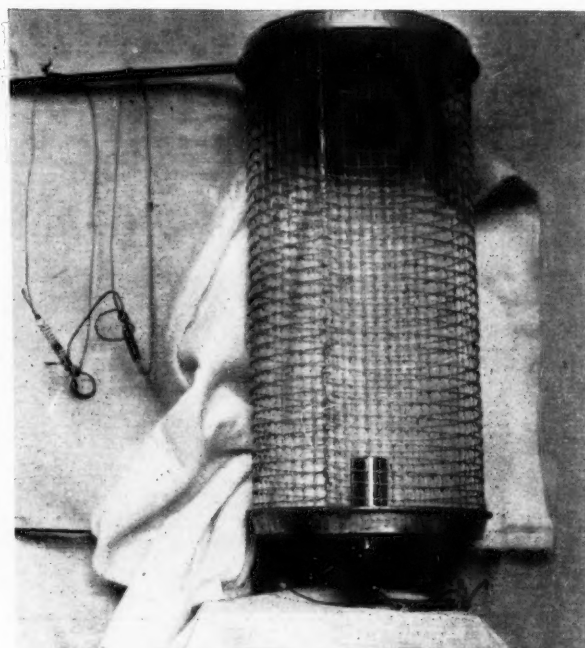


Fig. 24. Dry Cloth Cleaner

Eiderdown Cleaners Nos. 17 and 17', cloth laid back. 9-by-18-inch cylinder of wire screen soldered to heavy tin pans. Iron bars suitable for attachment to tractor riveted to end pans. Two thicknesses of eiderdown cloth, nap side out.

Dynamite Works Best in Wet Soil

IN ITS field experiments in clearing land with explosives, the department of agricultural engineering of the University of Wisconsin has studied the effect of soil moisture on the economic efficiency of stump blasting. Results show that it costs about fifty per cent more to remove stumps with dynamite during the dry part of the summer than in early spring or late fall when the soil is wet, other conditions being the same. Stumping under wet conditions saves dynamite, detonators, and labor. The advantage of blasting in the spring or fall, or at some other wet period of the year, may amount to \$20 an acre where there are one hundred stumps or more to the acre to be removed.

There are many times during the year when cultivated acres are too wet to work in. During such wet spells stumping operations can be carried on with profit and under most advantageous circumstances.

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Edited by R. W. Trullinger

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FUEL SAVING POSSIBILITIES IN HOUSE HEATING, L. M. Arkley and J. Govan. [Canada Council Scientific and Industrial Research Report, Ottawa, No. 10(1922), pp. 55, figs. 6.] This report presents data on the proper construction of houses and the operation of heating plants to effect economy of fuel consumption. It is divided into two parts: Part 1, by L. M. Arkley, deals with fuel saving in furnace installation and operation, describing methods of househeating and drawing special attention to proper chimney construction. Other factors considered are furnace operation, coal, air supply, pipe covering, and humidity. A set of rules for furnace operation is presented. Part 2, by J. Govan, deals with the advantages of better insulation, planning for sunlight and improved air conditions. A bibliography is appended.

FLOW IN TENNESSEE CHECKED AGAINST HYDRAULIC FORMULAS, B. E. Jones. [Engineering News-Record, 89(1922), No. 15, pp. 610-612, figs. 3.] In a contribution from the U. S. Geological Survey studies of data on the flow of water in the Tennessee River and in the Irrawaddy River in India are reviewed, the purpose being to show that the slope and hydraulic radius, through their influence on velocity, do affect the value of the coefficient C , or more accurately, the Ganguillet and Kutter formula does not allow fully for the effect of slope and hydraulic radius on the coefficient C . For both rivers it was found that for velocities up to 2.5 to 3 feet per second, an increase in slope is accompanied by an increase in the coefficient C . For higher velocities C tends to decrease as the slope increases. On the Tennessee River for higher velocities C increased with the hydraulic radius although the slope remained constant or even decreased. On the Irrawaddy River C remained fairly constant although both the slope and hydraulic radius increased.

These results are taken to indicate that the assumptions, that C in Chezy's formula does not vary with the slope and that C in the Ganguillet and Kutter formula increases with the slope when the hydraulic radius is less than one meter and decreases as the slope increases when the hydraulic radius is greater than one meter, are both wrong under certain conditions.

MANUFACTURE AND INSTALLATION OF PRECAST LOCK-JOINT CONCRETE PIPE, compiled by W. H. Nalder. [Reclamation Record (U. S.) 13(1922), No. 9, pp. 223-228, fig. 1.] Technical information on the design, manufacture, and installation of precast lock-joint concrete pipe, as practiced on projects of U. S. Reclamation Service, is presented.

FURTHER PROGRESS OF RURAL DISTRIBUTION, J. W. Purcell. [Electrical News, Toronto, 31(1922), No. 3, pp. 32-36; abs. in Sci. Abs., Sect. B—Elect. Engin., 25(1922), No. 293, p. 327.] An analysis of the distribution of electrical energy in rural districts in the Province of Ontario, Canada, is presented, indicating that the main classifications and descriptions of service required are (1) hamlet-service,

where four or more customers are served from one transformer suitable only for appliances up to from 600 to 750 watts, (2) house lighting, (3) light farm service, such as lighting and power for miscellaneous small equipment or single-phase motors not exceeding 3 horsepower, (4) medium farm service, single phase, for lighting and power using motors up to 5 horsepower, (5) medium farm service, three-phase, for use as in Class 4, (6) heavy farm service for lighting and power up to 10 horsepower, (7) special farm service for power for three-phase motors up to 20 horsepower and (8) syndicate service, which includes any of the above classes which may join in the use of a syndicate outfit. It is assumed that three farmers per mile of line or the equivalent are obtainable on an average. Tables of figures giving details and costs of installations, annual uses, annual cost, and work done are included.

MOTOR VEHICLE TRANSPORTATION, H. C. Spurr [Rochester: Public Utilities Reports, Inc., 1922, pp. 696.] The purpose of this volume is to bring together in convenient form the various rules, regulations, policies, and practices affecting motor vehicle transportation in the United States.

COEFFICIENTS OF DISCHARGE OF SEWAGE SPRINKLER NOZZLES, F. W. Greve, Jr. and W. E. Stanley [Purdue University Engineering Experiment Station Bulletin, Lafayette, Ind. 3 (1919), pp. 29, figs. 12.] The results of a series of experiments conducted to determine the coefficients of discharge of several types of sewage sprinkler nozzles are presented in this report.

It was found that the relation of the logarithms of head and discharge can be represented by a straight line for all of eight nozzles tested with the exception of a special round type. It is considered essential that care be taken in fixing the position of the cone in adjustable nozzles. Lowering the bottom of the cone below the level of the orifice was found to have a more serious effect on the rate of discharge than did the raising of the cone above the same level. This was brought about by the fact that the net area of the discharge opening was decreased as the cone was lowered. The coefficient of discharge remained constant for all nozzles when the head was greater than 1.5 feet except the round nozzle noted above. The rate of discharge for square nozzles could be increased by reaming the inner edge of the orifice.

A bibliography and tables of data are included.

IRRIGATION PRACTICE AND WATER REQUIREMENTS FOR CROPS IN ALBERTA, W. H. Snelson [Canada Department International Reclamation Service, Irrigation Service Bulletin, Ottawa 6(1922), pp. 59, pl. 1, figs. 26.] This is a contribution from the Reclamation Service of Canada in which practical information for beginners in irrigation is given, and the different systems of irrigation and their application to conditions in Alberta are outlined. Irrigation investigations at three experiment stations to determine the duty of water for different crops in Alberta are also described.

In studies at the Brooks experiment station it was found

that the total depth of water used which produced a maximum yield of wheat as a mean of twelve tests was 1.9 feet when applied in 4-inch irrigations and 2 feet when applied in 6-inch irrigations. Under optimum fertility conditions these figures were decreased approximately ten per cent and under poor conditions increased ten per cent. The depth of water used which produced the maximum yield of oats as a mean of thirteen tests was 1.62 feet when applied in 4-inch irrigations and 1.8 feet when applied in 6-inch irrigations. The depth of water used which produced the maximum yield of barley as a mean of eleven experiments was 1.67 feet when applied in 4-inch irrigations and 1.96 feet when applied in 6-inch irrigations. The maximum yield per acre of alfalfa was produced with a total application of water of 2.62 feet, of peas 2.25 feet, grasses 1.5 feet, alfalfa seed 1.48 feet, potatoes 1.65 feet, corn 1.36 feet and flax 1.34 feet.

The results of irrigation investigations at Ronalane, Alberta, and at Coaldale, Alberta, are also presented. The Coaldale data are taken to indicate that the average farmer applies an excessive amount of water per irrigation and allows too much water to escape by percolation and surface wash. The depths used at Ronalane were considerably greater than for similar crops at Brooks because of the smaller water-holding capacity of the Ronalane soil.

Data on the water-holding capacity of soils are also presented.

Tests of Self-Supporting Barn Roofs

(Continued from page 109)

After the design was completed on paper a quarter-size model was made and tested to verify the design. (See Fig. 4.) The three weights hanging on the truss gave the proper dead load. The wind load was applied at right angles to the surfaces and combined into one force by the system of wires, equalizer, and pulleys. The testing machine at the left applied and measured this force. After the first test the damage was repaired and five other tests made with several combinations of load. Stresses were calculated for each test so that every part of the truss would be loaded sufficiently. In one test the plate braces were moved to the studs to see if that would be a better location for them. The result of the tests was that the truss came fully up to expectations; in fact in some details the factor of safety was a little larger than necessary. Fig. 5 shows the redesign for a 60-mile-per-hour wind and a factor of safety of about 3. It should be noted that this truss uses much less lumber than the Shawver and even less than the common designs of braced rafter.

In conclusion, let me call attention to the possibilities for improving our barn roof plans; this does not mean that we must discover any new principles of mechanics. All we have to do is to study known principles of structural engineering, get the advice of men in that profession, and then simplify our method of construction if necessary so that we can apply these principles. Instead of a miscellaneous lot of boards nailed together with no clear idea of the function of each, can we not have simpler arrangements which can be planned with more intelligence? Doubtless further tests will be required to verify some points, but such tests are not difficult to make. And finally we need to give more attention to the joints and splices in our plans. When we know the stresses in the principal members we can specify how the joints shall be made. Our plans will then be working drawings instead of merely pictures. Joint construction is often more important than size of timbers and it is clearly our duty to specify such details.

A. S. A. E. and Related Activities

N. E. L. A. Rural Electric Lines Report

THE following abstract from the 1923 report of the Rural Lines Committee of the National Electric Light Association presented at the forty-sixth convention of the association held in New York City June 4 to 8, 1923, is of particular interest to agricultural engineers; if members of the Society care to have more of the details of this report, which is too lengthy for publication here, they will find considerable cost data from central station sources published in the report, which can be purchased from the association, 29 West 39th Street, New York City, at 25 cents per copy.

The Rural Lines Committee believes the rural electric service problems can be satisfactorily solved by increasing the use of electrical energy on the farm. The farmer cannot be expected to use electrical energy unless he can profit thereby and likewise the central station cannot be expected to sell electric service to the farmer for less than its cost plus a fair return on the necessary investment.

The committee appreciated that a great deal of research work and study of agricultural conditions was required before profitable increased use of electrical energy could be made by the farmer and also appreciated that no complete, accurate and satisfactory study could be made without the help of men who were familiar with farm methods and farm problems. The committee therefore as a first step toward starting such a cooperative study met on Sept. 11, 1922, with officials of the American Farm Bureau Federation and submitted the following statement:

The demand for rural electric service has produced an acute and embarrassing situation for the electrical industry due largely to the new and undeveloped state of the use of electrical energy on the farm. To develop the use of electrical energy on the farm the following suggestions are made:

1. The problem from both angles is:
 - (a) How service can be supplied to the farmer and what is involved in its establishment.
 - (b) How service can be utilized by the farmer so that it will be profitable to him.
2. It is believed that controversy is undesirable and that by co-operative efforts between the electrical and agricultural industries the problem can be solved to the best interests of all.
3. It is proposed that a cooperative organization representing these interests be formed to study the problem and to ascertain and put in form available for the use of anyone interested, the following:
 - (a) The various methods by which electrical energy can be profitably utilized on the farm including research studies of equipment characteristics as well as methods.
 - (b) The facts regarding the lines and equipment needed to give the farmer electric service comparable in quality with that already given in the industrial field.
4. The purpose of this proposed work is to ascertain facts. No selfish propaganda of any interest or class involved shall be allowed to enter.

This program was tentatively accepted by officials of the Farm Bureau as a basis for further discussion and a number of meetings were held at later dates and it was finally agreed that it would be necessary to get help from other agricultural organizations before a complete and satisfactory study could be made of this subject. Accordingly a meeting was arranged for and held in Chicago on March 8 and the following is a report given out by that joint committee which states what was done and what is hoped to be accomplished:

At a meeting held in Chicago, March 8, 1923, by representatives of the United States Department of Agriculture, American Farm Bureau Federation, American Society of Agricultural Engineers and the National Electric Light Association, the problem of the use of electricity in agriculture was discussed.

As a result of this conference a comprehensive study of the farm power problem was outlined. Involved in this proposed investigation will be a farm power survey covering all types of farm power generators such as horses and mules, steam engines, gas engines, windmills, electric motors, and man himself. This survey will include the collecting of data on the amount of power required for various farm operations, power requirements of various machines, and working it

into such a form as to make it readily adaptable to the special problem under consideration. It was emphasized that the arriving at an economic solution of this problem required, as a first step the fundamental analysis of all existing data.

It was further unanimously agreed that a complete survey of the present state of the use of electricity on the farm is desirable, and to this end plans were laid for an investigation which will reveal the number of farms being served by isolated plants and central station service. The National Electric Light Association will be requested to find the number of farm customers being served today, miles of rural electric lines, current used, farm operations for which electricity is used, and cost of this service to the farmer. An attempt will be made to secure similar data for the isolated plant.

It was recognized that the farmers rightfully look to the United States Department of Agriculture and various agricultural experiment stations for research information on fundamental agricultural problems. In view of the importance of the farm problem it was urged that these institutions institute investigations on the application of electricity to agriculture which will ultimately place information in the farmer's hands enabling him to make intelligent decisions regarding the application of electricity to his own problems. A complete investigation of the problems in this field will be urged. As the first step in this direction the Farm Power Committee of the United States Department of Agriculture will be requested to undertake the farm power survey and complete it as rapidly as possible. The various interests represented perfected the organization of the Committee on Electricity as Related to Agriculture with J. W. Coverdale, of the American Farm Bureau Federation as Chairman and G. C. Neff, Chairman of the Rural Lines Committee of the National Electric Light Association, as Secretary.

Outline of investigations to be carried on under general supervision of this committee:

1. Farm Power Survey
2. Survey of Central Station and Isolated Plant Services to farmers.
3. Survey of Agricultural Uses of Electricity in Foreign Countries.
4. Experimental and Research Work on the Uses of Electricity in Agriculture.

The work of this joint committee will undoubtedly be beneficial to both the utilities and the farmers. The information will be collected and analyzed through the cooperation of men familiar with both agricultural and utility problems and it is confidently believed that the cooperative efforts of these people will result in avoiding many mistakes and much duplication of work.

New Members of the Society

R. G. HEMPHILL, irrigation engineer, U. S. Department of Agriculture, Federal Building, San Antonio, Tex.

C. N. JOHNSON, general engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania.

TRANSFER OF GRADE

HAROLD T. BOYLE, Jackson, Nebraska. (From Student to Junior Member.)

ORVILLE BROWN BYRAM, Waverly, Iowa. (From Student to Junior Member.)

KAY I. CHURCH, 233 S. Wichita Street, Wichita, Kansas. (From Student to Junior Member.)

MERL STANLEY COOK, 1408 Fairchild Street, Manhattan, Kansas. (From Student to Junior Member.)

JOHN GUSTAVE GILSON, 143 Lincoln Way, Ames, Iowa. (From Student to Junior Member.)

DAVID JUNKIN, R. F. D. No. 2, Natchez, Mississippi. (From Student to Junior Member.)

ERNEST WINFRED TRUSSELL, Booneville, Mississippi. (From Student to Junior Member.)

STURGES L. VICTOR, 429 Lincoln Street, Onarga, Illinois. (From Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the June issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send pertinent information relative to the applicants for the consideration of the Council prior to election.

H. H. Barrows, senior drainage engineer, U. S. Department of Agriculture, 1402 L. Street, N. W., Washington, D. C.

Morris C. Betts, architect, investigation of the construction of farm buildings, U. S. Department of Agriculture, 437 Cedar Street, Takoma Park, Washington, D. C.

Thomas L. Callahan, experimental engineer, Moline Plow Company, Monitor Drill Branch, St. Louis Park, Minnesota.

Alfred Glendenning, West Dover, Ohio. (Transfer from Student to Junior Member.)

Arthur E. Jungmans, mechanical engineer and consultant to vice-president and general manager, Guantanamo Sugar

Company, Guantanamo, Cuba.

John Robert Schofield, 39 E. Norwich Avenue, Columbus, Ohio. (Transfer from Student to Junior Member.)

J. H. Stowers, R. F. D., Natchez, Mississippi. (Transfer from Student to Junior Member.)

Vilas D. Young, Galesville, Wisconsin. (Transfer from Student to Junior Member.)

EMPLOYMENT SERVICE

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members, as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

MECHANICAL AND ELECTRICAL ENGINEER, graduate of Cornell University and Armour Institute, with nineteen years of practical experience in designing, manufacturing, and marketing gasoline engines, automobiles, motor trucks, and tractors, having specialized particularly on internal-combustion motors and their application, prefers mechanical work cooperating with the different manufacturing and sales departments along the lines of sales engineering, or other work into which his qualifications would fit. MA-104

AGRICULTURAL ENGINEER wants position in southwest. Graduate of University of Illinois 1915, five years practical experience on Illinois farm with power equipment, two years in charge of the agricultural engineering department New Mexico College of Agriculture; considerable garage experience and service experience on unit power and light plants. Also one summer in Philadelphia battery service station. MA-106

AGRICULTURAL ENGINEER, graduating from Iowa State College June 10, 1923, would like position with some company or individual engaged in drainage or irrigation work. Five years' practical farm experience. MA-118.

GRADUATE AGRICULTURAL ENGINEER, now employed by tractor company, wishes position teaching agricultural engineering work. Will be available in summer or to start next fall. MA-115.

AGRICULTURAL ENGINEER, graduating from University of Illinois at end of present semester (available March 1, 1923) would like position in service department or experimental department of company manufacturing tractors or farm machinery. Three years' practical farm experience in West and one year in Illinois. Age 27. Unmarried. MA-116

DEVELOPMENT AND RESEARCH ENGINEER, technical graduate, inventive ability, practical, experienced in the development, design, manufacture, and distribution of farm machinery. Can carry through from the embryo idea, through development stages, production in manufacturing, and marketing. Age 29. Married. Excellent character. Available immediately. MA-117.

Positions Open

DRAFTSMAN who has had experience in designing and manufacturing threshing machinery with reliable, well-established farm-machinery manufacturer in central Pennsylvania. PO-1.

STUDENT FELLOW IN AGRICULTURAL ENGINEERING. There will be an opening beginning September, 1923, for a student fellow in agricultural engineering at the Virginia Polytechnic Institute. Write Charles E. Seitz, department of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. PO-4.

INSTRUCTOR IN AGRICULTURAL ENGINEERING. The department of agricultural engineering of the Virginia Polytechnic Institute has an opening for an instructor to handle farm surveying, farm buildings, farm concrete, and rural architecture. He will also devote part time to extension work. Write Charles E. Seitz, department of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. PO-5.

INSTRUCTOR IN AGRICULTURAL ENGINEERING. The department of agricultural engineering, Macdonald College, will have an opening beginning September 1 for an instructor in farm machinery, concrete work, farm sanitation, carpentry and drainage. Write L. G. Heimpel, Department of Agricultural Engineering, Macdonald College, P. Que., Canada. PO-6.

INSTRUCTOR IN FARM SHOP WORK and to carry on outside investigation along this line wanted by an agricultural college in the South. Salary \$2250 to \$2500. Ranking will be assistant or associate professor according to qualifications. PO-7.

EXTENSION AGRICULTURAL ENGINEER wanted immediately. Man with experience required. Salary according to training and qualifications and references. Also state minimum salary. PO-8.

INSTRUCTOR IN AGRICULTURAL ENGINEERING. The department of agricultural engineering, Macdonald College, will have an opening beginning September 1 for an instructor in farm machinery, concrete work, farm sanitation, carpentry and drainage. Write L. G. Heimpel, Department of Agricultural Engineering, Macdonald College, P. Que., Canada. PO-6.

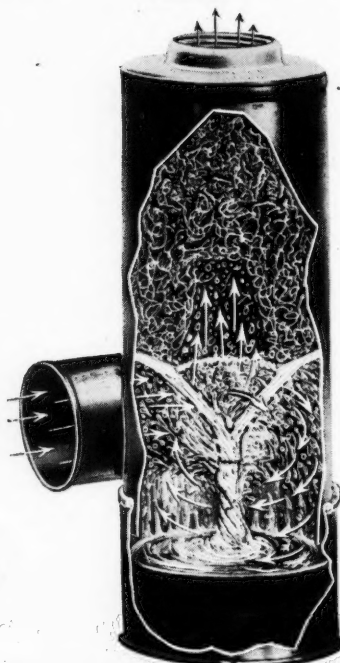
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EXTENSION AGRICULTURAL ENGINEER wanted immediately. Man with experience required. Salary according to training and experience. Write University of Nebraska, Lincoln, giving qualifications and references. Also state minimum salary. PO-8.

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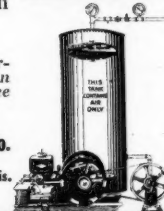


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